Original Article

Comparison of the utility of the Pentax Airway Scope (AWS) with that of the conventional Macintosh laryngoscope during chest compression: is the AWS an easy-to-use device for a novice?

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Aim: The Pentax Airway Scope occasionally contacts the arm of the chest compressor at insertion because of its large body. Here, we test the Airway Scope's ease of use compared to that of the conventional Macintosh laryngoscope during chest compression, when operated by a novice.

Methods: We recruited 73 participants into this simulation study. Each participant carried out tracheal intubation using the two devices without and with chest compression. We recorded the time to intubation and the success rate. All of the participants completed a brief questionnaire after finishing the attempts.

Results: Data are medians and ranges. The time to intubation (seconds) without and with chest compression were 11 (7–57) and 13 (7–90) by the Macintosh laryngoscope, respectively, and 14 (6–46) and 15 (6–69) by the Airway Scope, respectively. The difference in the time to intubation between the groups without and with chest compression was significant for the Macintosh laryngoscope ($P = 0.0434$) but not significant for the Airway Scope. The time to intubation in the Airway Scope attempts were slightly longer than those in the Macintosh laryngoscope attempts (not significant). The success rate using the Macintosh laryngoscope with chest compression was significantly lower than that without chest compression (92% versus 100%, $P = 0.0124$). The success rate using the Airway Scope was 100%, but an accident occurred in four attempts. The questionnaire revealed that 54 participants preferred the Airway Scope and 19 preferred the Macintosh laryngoscope.

Conclusion: The Pentax Airway Scope appears to be better than the Macintosh laryngoscope during chest compression if the operator is a novice. However, using the Airway Scope does not always reduce the time to intubation.

Key words: Chest compression, Macintosh laryngoscope, manikin, Pentax Airway Scope, tracheal intubation

BACKGROUND

SEVERAL STUDIES DESCRIBE the usefulness of the Pentax Airway Scope (AWS; Pentax, Tokyo, Japan) during chest compression.[1,2] These studies found that using the AWS reduced the time to tracheal intubation and provided successful tracheal intubation during chest compression compared to the conventional Macintosh laryngoscope (MCL).[1,2]

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Received 21 Nov, 2013; accepted 5 Feb, 2014; online publication 23 Apr, 2014

However, the AWS is larger than the MCL and we sometimes find that the AWS contacts the arm of the chest compressor; we feel that this is a disadvantage. Previously, only one study discussed the large body of the AWS.[3] In the present study, we validated the AWS' ease of use compared to that of the MCL by beginners during chest compression.

METHODS

WE RECRUITED 73 participants (50 medical university students, 13 initial trainee doctors with <1 year clinical experience, and 10 medical vocational school students) into this simulation study. Some of the participants had used an MCL in another manikin model. None of the participants had any experience using an AWS.

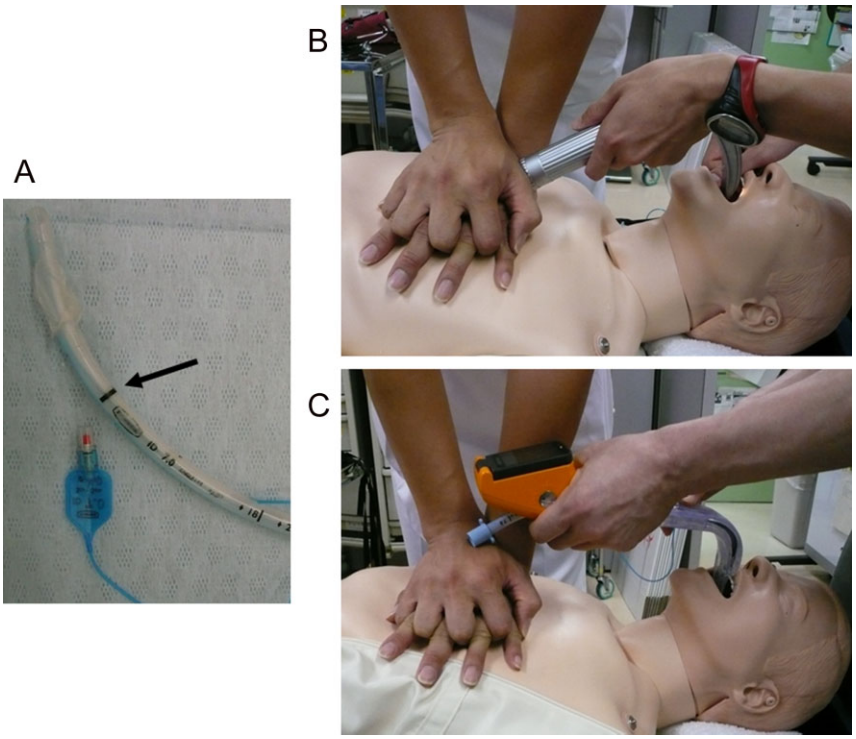


Fig. 1. A, Using the Pentax Airway Scope, the endotracheal tube was inserted until the tube's thick black line (black arrow) was located at the manikin's glottis. B, The Macintosh laryngoscope did not contact the arm of the chest compressor at insertion. C, The Pentax Airway Scope or tip of the endotracheal tube contacted the arm of the chest compressor at insertion.

All of the participants practiced tracheal intubation using the MCL and the AWS in a manikin without chest compression until they achieved successful tracheal intubation. After the practice, they carried out tracheal intubation in the following order: MCL without chest compression; MCL with chest compression; AWS without chest compression; AWS with chest compression. Chest compression was carried out by an Advanced Cardiac Life Support provider according to the Basic Life Support guidelines. He began the chest compression before the participant started the attempt and continued the chest compression until the participant finished the attempt. Chest compression was done by the same Advanced Cardiac Life Support provider in order to standardize the power of chest compression. To avoid fatigue of the chest compressor, all of the participants were asked to complete the attempt within 90 seconds, and the study was carried out with up to five participants a day.

We used the AirMan manikin (Laerdal Medical, Stavanger, Norway), which was placed on a flat solid table, and all of the attempts were carried out at the same level from the floor. We used a size 3 blade for the MCL and a standard Intlock blade for the AWS. We used an endotracheal tracheal tube (Portex, St. Paul, MN, USA) with an internal diameter of 7.0 mm and inserted a stylet into the tube in the attempts using the MCL.

We measured the time to intubation (TTI) of each intubation attempt. For the MCL attempts, the TTI was defined as the duration from grasping the device to removing a stylet from the intubated tube. For the AWS attempts, the TTI was defined as the duration from grasping the device to removing the Intlock blade from the manikin's mouth, as was done in the Shin study.[4] In the MCL attempts, the endotracheal tube was inserted until the 21-cm scale of the tube was located at the right corner of the manikin's mouth. In the AWS attempts, the endotracheal tube was inserted until the tube's thick black line (the black arrow in Fig. 1A) was located at the manikin's glottis. Even if an accident occurred, we did not interrupt the TTI measurement until the participant finished the attempt. We also recorded the success rate (SR) of tracheal intubation. We defined "failed tracheal intubation" as either esophageal intubation or exceeding the time limit of 90 seconds for the attempt.

All 73 participants completed a brief questionnaire after finishing the attempts. The questionnaire asked "Which do you prefer, the MCL or the AWS during chest compression?" and "Please give your impressions of each device."

The data collected did not include any personal information that would identify any of the participants, and thus, informed consent from the participants was waived, based on the Ethical Guidelines for Epidemiological Studies, issued

jointly by the Ministry of Health, Labour and Welfare and the Ministry of Education, Culture, Sports, Science, and Technology of Japan.

All statistical analyses were carried out using the software program Excel Tokei 2012 (Social Survey Research Information Co., Tokyo, Japan). Intergroup differences were assessed with the χ^2-test with Yates' correlation for continuity in categorical variables. The Mann–Whitney *U*-test was used to test for differences in continuous variables. We considered *P*-values <0.05 significant.

RESULTS

FIGURE 1B,C SHOW THAT the MCL never contacted the arm of the chest compressor, but the AWS or the tip of the endotracheal tube contacted the arm of the chest compressor.

Figure 2 shows the TTIs for each device (median and range). The difference in the TTIs between with and without chest compression was significant for the MCL ($P = 0.0434$) but not significant for the AWS. Although the TTIs using the AWS were longer than those using the MCL, the difference was not significant.

Table 1 provides the TTI details and the SR for each device. For three participant-type groups, there was no significant difference in the TTI among all the attempts. Six participants displaced the tube into the esophagus when they used the MCL with chest compression. The SR using the MCL with chest compression was significantly lower than that without chest compression (92% versus 100%, $P = 0.0124$). The SR using the AWS both with and without chest compression was 100%. However, there were four accidents during the AWS attempts with chest compression. Accidental extubation during the removal of the Intlock blade from the mouth occurred in one attempt. The endotracheal tube was detached from the side channel of the Intlock blade during contact with the arm of the chest compressor in three participants' attempts. They repeated the attempts by themselves and achieved successful tracheal intubation.

Figure 3 shows the results of the questionnaire. Approximately three-quarters of the participants preferred the AWS. There were no significant differences in the frequency of preferring the AWS among three participant-type groups.

Figure 4A shows the TTIs in the participants who preferred the MCL. The TTIs using the AWS were significantly longer than those using the MCL without and with chest compression. The difference in the TTI between without and with chest compression was significant for the AWS ($P = 0.0001$) but not significant for the MCL. Figure 4B shows the TTIs in the participants who preferred AWS. There was no significant difference in the TTIs between the use of each device.

DISCUSSION

SEVERAL STUDIES VALIDATED the usefulness of the AWS during chest compression.[1,2,4–6] The characteristics of the AWS use described in those studies are shown in Table 2. In those studies, all of the participants had experienced using the MCL, but almost all of the participants were

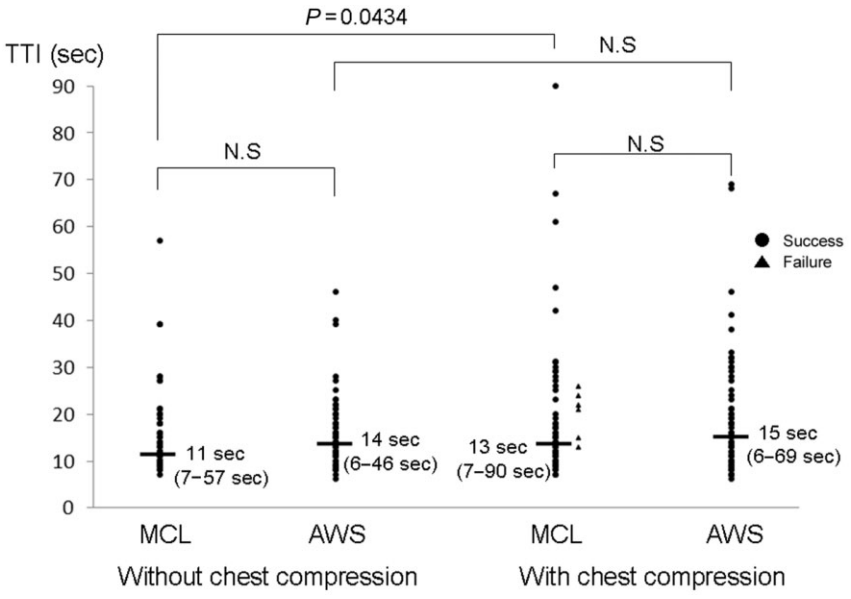
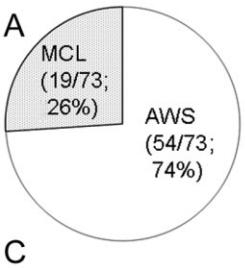


Fig. 2. Scatter graph of the time to tracheal intubation (TTI) in all participants using the Pentax Airway Scope (AWS) and Macintosh laryngoscope (MCL) without and with chest compression. The thick bar indicates the median TTI. Closed circles indicate successful tracheal intubation; closed triangles indicate failed tracheal intubation. N.S, not significant; sec, seconds.

Table 1. Time to intubation (TTI) and success rate (SR) for the Pentax Airway Scope (AWS) and conventional Macintosh laryngoscope (MCL) in novice operators

	Without chest compression		With chest compression	
	MCL	AWS	MCL	AWS
TTI (sec)				
Medical university students	12 (8–57)	14 (8–46)	13 (7–90)	14 (6–69)
Initial trainee doctors	10 (8–27)	13 (6–27)	14 (8–47)	20 (9–32)
Medical vocational school students	9.5 (7–16)	11 (8–19)	14 (8–28)	11.5 (7–46)
All of the participants	11 (7–57)	14 (6–46)	13 (7–90)	15 (6–69)
SR (%)				
Medical university students	100	100	92 (four failed)	100
Initial trainee doctors	100	100	92 (one failed)	100
Medical vocational school students	100	100	90 (one failed)	100
All participants	100	100	92 (six failed)	100

sec, seconds.



B

	AWS	MCL	Total
Medical university students	37	13	50
Initial trainee doctors	10	3	13
Medical vocational school students	7	3	10
Total	54	19	73

C

Device	Impression	Major comments	Number
AWS	AWS - Positive	Clear visibility of glottis is easily available	27
		Target sign on the monitor is useful	17
		Less force is needed to confirm the glottis	5
	MCL - Negative	Receiving the tube needs several seconds	5
MCL	MCL - Positive	Handling of the compact grip is better	8
	AWS - Negative	Handling of the large grip is difficult	6
		Manipulation of thick Intlock blade is difficult	5

Fig. 3. A, Proportions of participants who preferred the AWS or the MCL. B, Number of participants who preferred the AWS or the MCL in each participant-type group. C, Comments regarding positive and negative impressions of the AWS and the MCL by all of the participants.

unfamiliar with the AWS. The difference in the experience between the two devices in the present study was similar to the difference in those studies.

Except for two studies,[2,6] the TTIs using the MCL with chest compression was significantly longer than those without chest compression. In addition, except for the Kim study,[6] the SR using the MCL with chest compression was significantly lower than that without chest compression. For the AWS in those studies, there were no significant differences in the TTIs between with and without chest compression, and the SR using the AWS was 100%. In the MCL attempts, the glottis moved due to chest compression and the relative positions of the glottis and endotracheal tube were not stable.[7] In the AWS attempts, the relative positions of the glottis and endotracheal tube in the monitor were stable.[7] The difference of the stability in the larynx during chest compression can influence the differences in the TTI or SR between the two devices.

However, a few studies obtained different results.[2,6] In the Han study,[2] the TTI in MCL attempts with chest compression was shortened. The authors contended that the improvement of the participants' skills as each attempt progressed was the

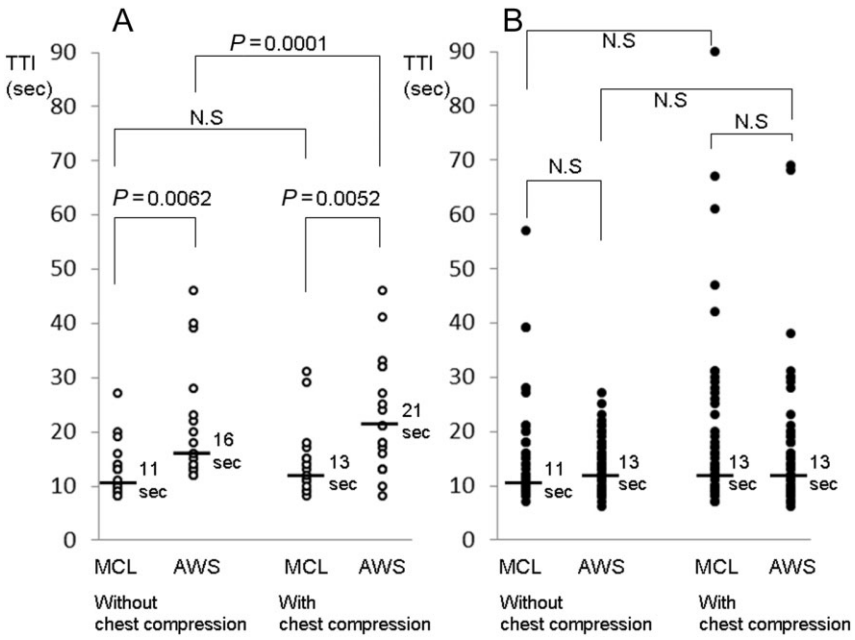


Fig. 4. Scatter graph of the time to intubation (TTI) using the Macintosh laryngoscope (MCL) or the Pentax Airway Scope (AWS) without and with chest compression in those participants who preferred the MCL (A) or AWS (B). The thick bar indicates the median TTI. Open circles (A) indicate the TTIs in the participants who preferred the MCL and closed circles (B) indicate the TTIs in the participants who preferred the AWS. N.S, not significant; sec, seconds.

Table 2. Characteristics of Pentax Airway Scope (AWS) and conventional Macintosh laryngoscope (MCL) use described in previous studies

Author	Participants	No. of participants	Without chest compression		With chest compression	
			MCL	AWS	MCL	AWS
			Median TTI (sec)/SR (%)	Median TTI (sec)/SR (%)	Median TTI (sec)/SR (%)	Median TTI (sec)/SR (%)
Komasawa *et al.*[1]	Trainees with <2 years of experience	13	13.9/100	11.8/100	22.5/77	11.9/100
Komasawa *et al.*[1]	Anesthesiologists with >5 years of experience	12	11.3/100	10.9/100	17.3/100	11.0/100
Han *et al.*[2]	Medical interns with <10 tracheal intubations	22	18.1/94	15.4/100	16.6/81	13.5/100
Shin *et al.*[4]	Junior interns with <10 tracheal intubations	32	16.5/97	12.1/100	30.1/75	13.9/100
Komasawa *et al.*[5]	Novice doctors with <1 year of experience	19	21.3/86	16.9/100	27.8/48	18.8/100
Kim *et al.*[6]	Emergency physicians with >50 tracheal intubations	22	15.6/96	13.6/100	17.1/91	14.2/100

sec, seconds; SR, success rate; TTI, time to intubation.

reason for their results. In the Kim study,[6] there was no significant difference in the TTI or SR using the MCL between without and with chest compression. The authors mentioned that the operator skills based on an adequate amount of experience would influence their results. However, Komasawa *et al*.[8] proposed that the AWS requires less operator skill. Considering these past findings, it appears that the AWS will be useful to achieve successful tracheal intubation during chest compression compared to MCL even if the operator is a novice.

The TTI using the AWS with chest compression was significantly shorter than that using with MCL in the studies

mentioned above. However, we observed the opposite result (although it was not significant) and considered the factors related to our results.

First, the manipulation of the endotracheal tube and the thick Intlock blade was not easy for some of our participants. Enomoto *et al*.[3] reported that it took more time to detach the endotracheal tube from the side channel of the Intlock blade. In addition, they reported that the time needed to identify the glottis was significantly shorter with the AWS compared to the MCL, but there was no significant difference in the TTIs between the two devices.[3] However, locating the thick black line in the tube at the glottis was not easy. During the intubation attempts, the participants could lose sight of the black line. They also needed to take the tube in and out several times to adjust the black line at the glottis. Unfortunately, we did not measure the time to manipulate the endotracheal tube. Hence, we could not carry out a further analysis. We consider that it will be necessary in the future to measure the timing of each step in the AWS intubation attempt.

Second, the large grip of the AWS was not easy to use for some of the participants. Cho *et al*.[9] reported that the AWS was more difficult to handle than the MCL, and Kim *et al*.[6] reported that the AWS contacted the arm of the chest compressor. In the present study, three participants experienced accidents when the AWS or the tip of the endotracheal tube contacted the arm of the chest compressor, and some of the participants inserted the AWS obliquely into the manikin's mouth in order to not contact the arm of the chest compressor. Recently, a new thin Intlock blade for the AWS and smaller-sized videolaryngoscopes have been made available. In the future, we would like to carry out further analyses using the new blade or the new devices.

Most of our participants who preferred the MCL took significantly longer times with the AWS and tended to have a negative impression of the AWS. Conversely, most of our participants who preferred the AWS took the same amount of time in the manipulation of the MCL and some had a negative impression of the MCL. It was thought that the participants who quickly comprehended the characteristics of the AWS during the practice session before the intubation attempts preferred the AWS.

The difference in the median TTI between the AWS and the MCL was 2–3 seconds. Although the clinical significance of this difference is questionable, it is ideal that tracheal intubation is achieved within one cycle of cardiopulmonary resuscitation (CPR) in order to maintain the quality of CPR.[2] If the chest compression is carried out according to the Basic Life Support guideline, the time of one cycle of CPR will be around 18 seconds. The TTI in the present study did not include the time for inflating the cuff, connecting a self-inflating bag to the intubated tube, or starting manual ventilation. Several seconds are needed to start ventilation, and the total time must be longer than 18 seconds. Reducing the TTI is also important to maintain the quality of CPR, and it should be kept in mind that the AWS does not always reduce the TTI when the operator is a novice.

There are several limitations in the present study. First, this is a manikin-based rather than a clinical study. The manikin model may not reproduce the precise intubation conditions of real patients. Second, chest compressions on a manikin model cannot represent CPR on real patients. Although the manikin used in the present study is designed for training in simulated chest compression and airway management, differences between a manikin model and real patients may exist. Thus, it is difficult to predict how the present study's results translate into real clinical conditions. Third, a precise comparison of the usefulness of the AWS and the MCL was difficult because some of the participants had experience with the MCL and all of the participants were unfamiliar with the AWS. We cannot deny the possibility that the difference of experience influenced the results. Fourth, the present study was not a randomized crossover study. Therefore, improvement in the participants' skills as each attempt progressed may have occurred. The TTIs using the MCL with chest compression (the second attempt) were shorter than those without chest compression (the first attempt) in 20 participants. The TTIs using the AWS with chest compression (the fourth attempt) were shorter than those without chest compression (the third attempt) in 33 participants. The aim of the present study is to compare the utility of the MCL and that of the AWS. Hence, a possible improvement in skills may have invalidated the comparison between the two devices. To avoid this problem, a randomized crossover trial is recommended. The reports mentioned above[1,2,4–6] were also designed as randomized crossover studies in order to minimize any learning effects during the trial. However, it has been reported that a randomized crossover trial could not always exclude the learning effects.[2,6] Therefore, we may obtain similar results; however, in the future, randomized trials will be needed in a manikin receiving chest compression in order to confirm the results of the present study.

CONCLUSIONS

THE AWS WILL be more useful than the MCL for tracheal intubation and the clear visibility of the glottis, even when the operator is a novice. However, the AWS may not be better for reducing the TTI.

CONFLICT OF INTEREST

NONE.

ACKNOWLEDGEMENTS

WE THANK ALL of the staff of the Department of Emergency and General Medicine and the Department of Intensive Care Medicine, Kumamoto University Hospital. We also acknowledge the participants in the present study.

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